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ABSTRACT

This report compares the projected savings of using computer based training to conduct training for newly hired pilots to the results of that application. New Hire training, one of a number of programs conducted continuously at the United Airline Flight Operations Training Center, is designed to assure that any newly hired pilot will be able to enter and meet the objectives of any of the regular Transition Training Programs (to qualify pilots when they move from one type of aircraft to another) without modifying the existing program. In view of the wide range of student experience in each class, it was decided that the principles of criterion referenced instruction should be used, and the PLATO Computer Based Training System was selected for the application. The findings of this study indicate that the application of criterion referenced, individualized instruction as administered with the help of a computer based training system having good computer managed instruction capabilities has realized substantial savings over the traditional method of instruction; figures for the newly implemented Pilot Skills Training and Assessment portion of the course--using an average of five hours in a flight simulator over a 3-day period for each student--were not included. (JEG)

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UNITED

RESULTS OF

COMPUTER BASED TRAINING

UNITED AIRLINES
Flight Training Center
Stapleton International Airport
Denver, Colorado

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United Airlines Flight Standards and Training
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November, 1978

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The objective of this report is to compare the projected savings of using CBT (Computed Based Training) to conduct training for newly hired pilots to the results of that application.

The United Airlines Flight Operations Training Center, located in Denver, Colorado, is a central facility responsible for all training of United Airlines' 5,500 pilots. The largest activity is Transition Training which qualifies pilots when they move from one airplane type to another. In addition, semi-annual Proficiency Training, semi-annual Proficiency Checks, Recurrent Training, Requalification Training, Emergency Procedures Training for both pilots and flight attendants and New Hire training is conducted continuously.

All training programs are designed, produced and administered by the Flight Training Center within the organization shown in Figure 1.

The Flight Training Program Development group was charged with the responsibility to develop a training program for newly hired pilots in November of 1976. Specifically, the charge was to develop training that would assure that any newly hired pilot would be able to enter any of the regular Transition Training programs prepared to meet the objectives of that program with no modifications to the Transition Training program. This meant that new pilots must be brought up to the entry level of knowledge on which the Transition Training programs are based. To compound this problem the expectations of the availability of pilot candidates and the qualification standards for selection led us to expect a wide range of student experience in each class from the very beginning. We could expect students with experience ranging from light airplane time to those with extensive multi-engined jet experience from the military.

Based on prior research and investigations, the Flight Training Program Development group felt this situation called for the application of CRI (Criterion Referenced Instruction) principles.

A Computer Based Training Proposal was presented to the Senior Vice President of Flight Operations in May of 1977 and subsequently adopted. The conclusions and recommendations of that proposal as they apply to the New Hire Training program were:

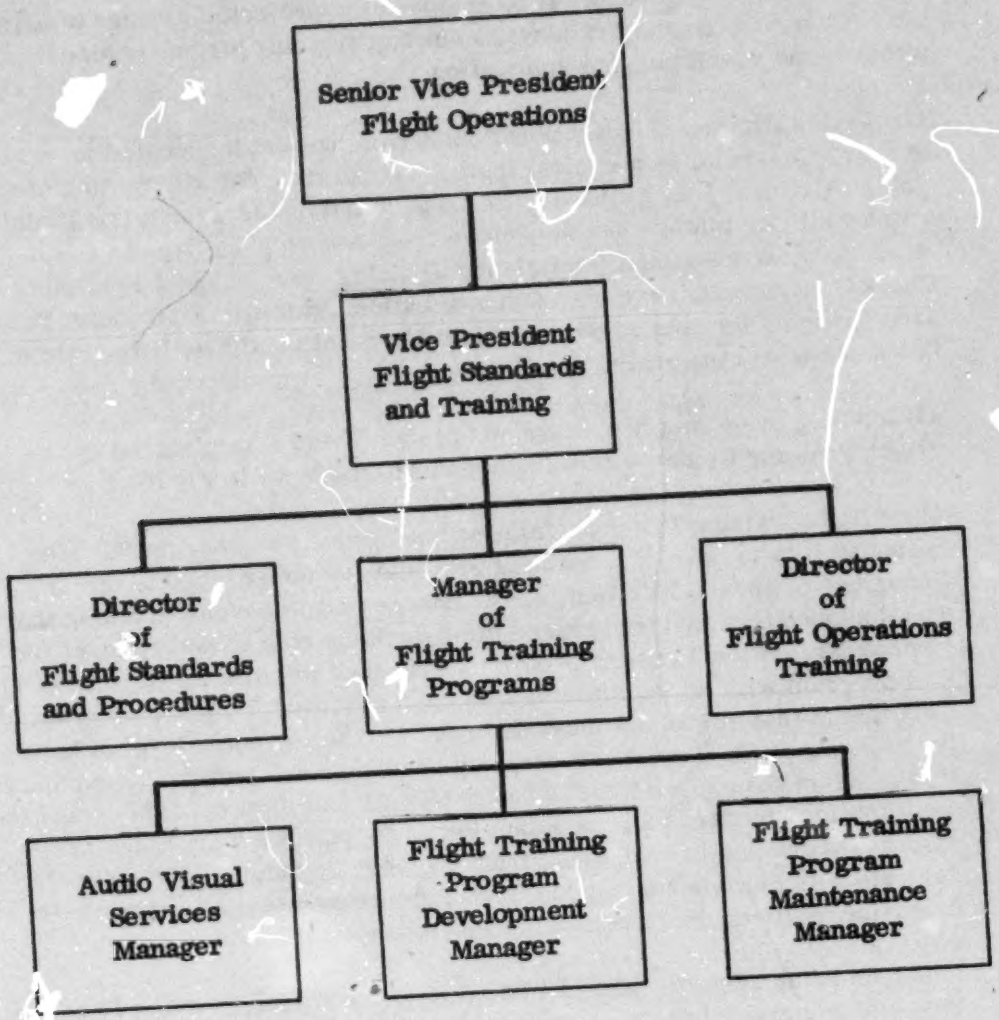
Senior Vice President
Flight Operations
Vice President
Flight Standards
and Training
Director
of
Flight Standards
and Procedures
Manager
of
Flight Training
Programs
Director
of
Flight Operations
Training
Audio Visual
Services
Manager
Flight Training
Program
Development
Manager
Flight Training
Program
Maintenance
Manager

FIGURE 1

Conclusion:

"Computer Based Training has evolved to the point where United Airlines Flight Standards and Training should conduct a practical evaluation of its utility through direct application to real training needs. The evaluation should be conducted in the Flight Training Center environment as part of the operational training activity."

Recommendation

"United Airlines Flight Standards and Training should lease the PLATO Computer Based Training System from Control Data Corporation in order to accomplish the evaluation."

Rationale

There were several factors stated to support the recommendation to implement CBT:

"Individualized Instruction is the key to providing qualified flight crew members at the least cost, and CRI is the key to individualization.

Computer Based Training is essential, because it appears to be the only effective way to implement Criterion Referenced, Individualized Instruction in the flight crew training environment."

The principles involved in this type of training were described by United Airlines in a paper presented to the International Air Transport Association's Fourth General Flight Crew Training Meeting, Lucerne, Switzerland in November of 1976:

"United Airlines Flight Operations Training has learned a great deal about the application of the Systems Approach to Training from our earlier efforts. We are convinced now that criterion tests play a much bigger part in training design than we previously appreciated. In fact, United Airlines Flight Operations Training believes that

evaluation should control training content. Past practices have indicated that any success or failure in controlling training content has ultimately been dependent upon evaluation. There is no reason to expect this fact to change. We believe this understanding can be used to help improve training efficiency.

"An understanding of the rationale for evaluation as control of training content is essential. The premise is:

> 'The only basis on which to judge trainees to be ready for the job is their successful performance on criterion tests. The tests specify what the trainee must do, in a training situation, to meet the performance standard. These documented tests are agreed to by all concerned parties.'

"An acceptance of this principle allows the content of training to be as much or as little as a particular trainee needs to help him master the criterion tests. The number of hours a trainee might spend in training, or the amount of information he or she is exposed to, should have no effect on what he or she would be held accountable for. The potential impact on training time becomes readily apparent."

The need for a CBT system was addressed:

> "The necessity for a Computer Based Training system over a manual system (to administer a CRI program) is dictated by the complexity of the training task and the necessity for a very high degree of control over our 'end product,' a qualified flight crew member. Errors in record keeping of performances on criterion tests cannot be tolerated in our environment. All parties (Company, FAA, Instructors and Flight Crew Members) must be assured of complete satisfactory performance on all criterion tests."

An additional reason for the acquisition of a CBT system was included:

> "Wide variations exist in experience levels in New Hire selectees as well as in lower seniority transition programs. An individualized program, suitably lean and responsive, is

highly dependent upon accurate and accessible records of trainee performance, prerequisite training requirements, and scheduling of staff and equipment resources. Record keeping processes for these purposes are too complex to be handled manually."

A significant point of the proposal was to enter into an evaluation of CBT by using it to meet a real training need.

> "The application of Computer Based Training should be on a real training program, rather than a research and development effort. This approach allows the Flight Training Center to realize savings for an active program while gaining experience in using the system. Sufficient information exists about Criterion Referenced Instruction programs and Computer Managed Instruction to use this approach with confidence."

The CBT systems available were evaluated and PLATO was selected.

> "Leasing the PLATO system allows the Flight Training Program Development group the opportunity to gain experience with the full capabilities of Computer Based Training with minimal risk. If, after the evaluation period, Computer Based Training proves to be efficient and successful, the option to buy a system still exists.
>
> "The PLATO system can be tailored to effectively meet the training needs either by expanding or shrinking the amount of capability. The capability of use can be modified with 30 days notice. If a different system were purchased, requiring a major commitment of funds, there is little flexibility."

The application of the PCMI (PLATO Computer Managed Instruction) system was ideally set up to conduct our application for newly hired pilots. The proposal included this summary of the program:

> "The New Hire Pilot Training program titled 'Advanced Aeronautical Training and Job Related Training,' will be a criterion based program designed to recognize and

evaluate previous aeronautical knowledge and experience possessed by the pilot. Training will consist of a number of courses, such as Meteorology, Aerodynamics, Federal Aviation Regulations, Company Operating Requirements, etc. Each Module will be broken down into Instructional Units such as Atmosphere and the Affects of Heat and Moisture, Stability and Cloud Formation, Static and Dynamic Stability, Flight Characteristics.

"To complete a course, all trainees must satisfactorily complete a Criterion Test that will demonstrate mastery within prescribed parameters for that particular course. If the trainee possesses required knowledge and experience to pass the Criterion Test without taking the training first, he may do so and save training time normally required to complete the course."

When training was conducted for newly hired pilots the last time, over eight years ago, the program was four weeks long. It consisted of twenty days of traditional instruction covering generally the same materials planned for the new program. Those days were mostly classroom work for about six hours per day. Four weeks was conceded to be the time it would take to do the same job today if we were to use traditional methods.

Since there was a commitment to apply CRI principles to this new program, estimates were made on the times that various categories of students, based on type of experience, as to the time of training expected for each category. Our estimates showed a range of seven days for multi-engined jet experienced pilots to fifteen days for experience of less than 500 hours of flying time.

Figure 2 shows the basis for those estimates.

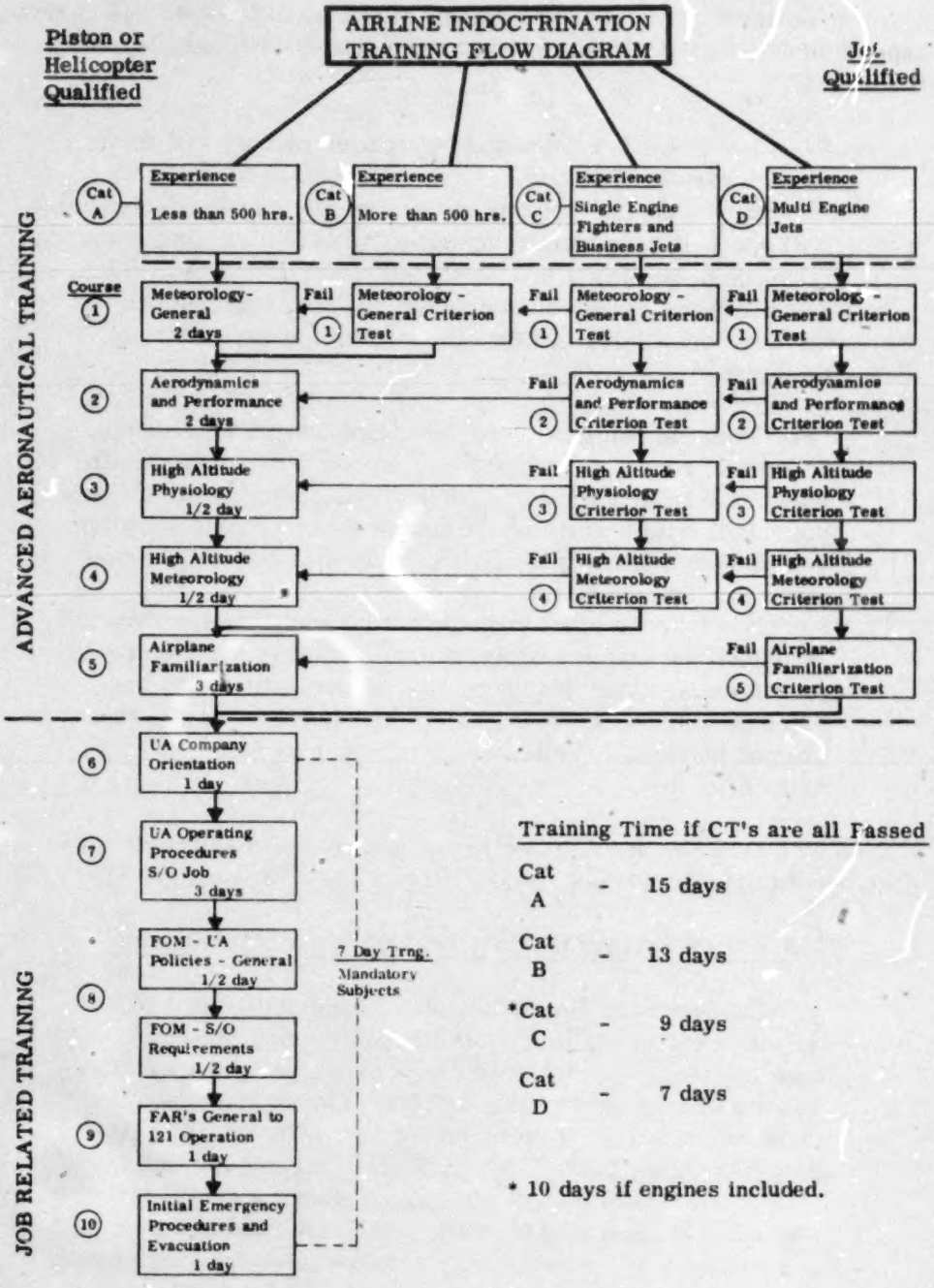
AIRLINE INDOCTRINATION TRAINING FLOW DIAGRAM
Piston or Helicopter Qualified
Jet Qualified
ADVANCED AERONAUTICAL TRAINING
JOB RELATED TRAINING
Cat A
Experience
Less than 500 hrs.
Cat B
Experience
More than 500 hrs.
Cat C
Experience
Single Engine Fighters and Business Jets
Cat D
Experience
Multi Engine Jets
Course
1 Meteorology - General 2 days
Fail 1 Meteorology - General Criterion Test
2 Aerodynamics and Performance 2 days
3 High Altitude Physiology 1/2 day
4 High Altitude Meteorology 1/2 day
5 Airplane Familiarization 3 days
Fail 2 Aerodynamics and Performance Criterion Test
Fail 3 High Altitude Physiology Criterion Test
Fail 4 High Altitude Meteorology Criterion Test
Fail 5 Airplane Familiarization Criterion Test
6 UA Company Orientation 1 day
7 UA Operating Procedures S/O Job 3 days
8 FOM - UA Policies - General 1/2 day
FOM - S/O Requirements 1/2 day
9 FAR's General to 121 Operation 1 day
10 Initial Emergency Procedures and Evacuation 1 day
7 Day Trng. Mandatory Subjects
Training Time if CT's are all Passed
Cat A - 15 days
Cat B - 13 days
*Cat C - 9 days
Cat D - 7 days
* 10 days if engines included.

FIGURE 2

Another aspect of the proposal indicated the value of the data generation aspects of CRI that would be very helpful in the validation of learning resources:

> ".... The Computer Managed Instruction system will generate a variety of statistical records to allow an author to determine the effectiveness of the various learning resources. With the ability to identify specifically which learning resource is not doing the job it can be revised and revalidated. This capability provides the opportunity and the responsibility to be fully accountable for the effectiveness of each learning resource.
>
> "For example, an instructor feels that information should be added to a course for which he is responsible. This feeling may come from a variety of indications, some valid and some not. But, with trainee performance data available showing satisfactory performance on the particular set of criterion tests, for the objectives covered by the author's course, we can show why the course should not be lengthened. This will help keep the training program from growing without proper justification. And, a shorter course that still meets the objectives means lower costs. Accountability for the effectiveness of learning resources will help manage training costs more effectively."

Armed with the previously stated principles and base assumptions a cost/benefits analysis was presented for the New Hire program:

> "$29,827.00 Savings in First Year of New Hire Program
>
> PLATO Computer Based Training including the course development work, Computer Based Training System training and instructor training, and one year of operation results in a savings of $29,827.00. This savings is based on an average annual requirement for 367 trainees beginning in January 1978. This indicates that to establish the PLATO Computer Based Training system and use it for Computer Managed Instruction of the New Hire training program actually saves money with the first year's trainees. This demonstrates the value of applying the technology to a

real training need to evaluate it in the flight training environment as opposed to a straight research and development effort. Cost reduction exceeds costs after 15½ months."

The cost savings were calculated as shown in Figure 3.

NEW HIRE TRAINING PROGRAM

Figures Based On:

Trainee Salary	$1,000. per month
FOI Salary and Benefits	$2,395. per month
No. of Trainees	367 per year

WITHOUT PLATO		WITH PLATO	
15 Days per Trainee	$253,964./Yr.	11 Days per Trainee	$186,069./Yr.
7 FOIs	$201,180./Yr.	5 FOIs	$143,700./Yr.
		PLATO Costs	
		Pre-training Costs PLATO Lease and Communications	$ 25,844./Yr.
		1 Year of Training PLATO Lease and Communications	$ 69,704./Yr.
TOTAL	$455,144./Yr.	TOTAL	$425,317./Yr.

With PLATO, costs are $29,827. less after one year of training.

FIGURE 3

Figure 4 shows cost versus savings based on proposal estimates.

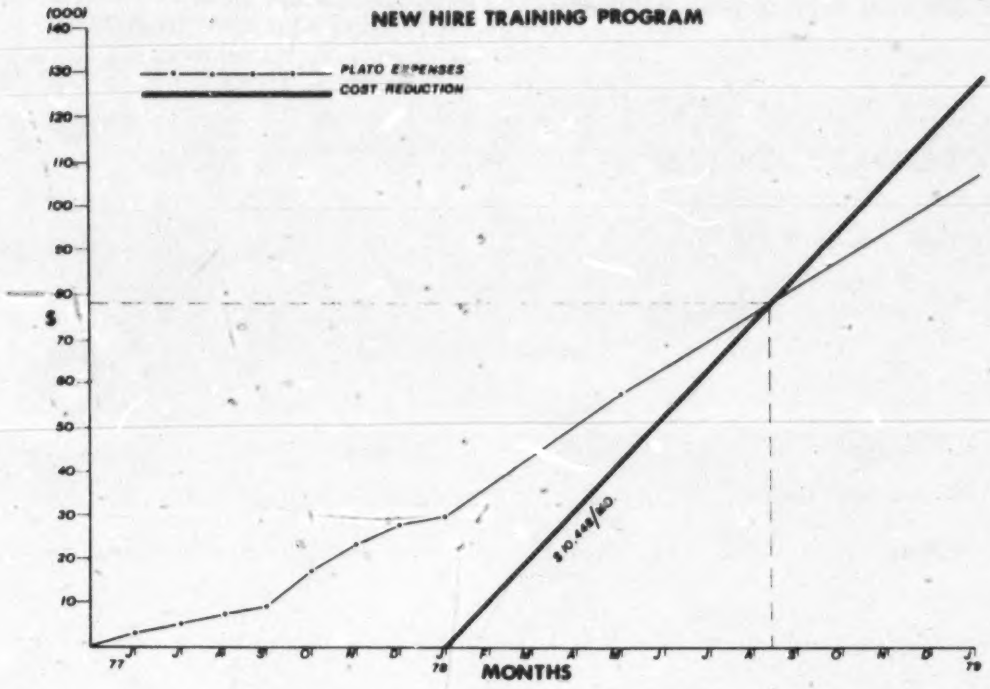

FIGURE 4

It is important to note that there are no costs allocated to the development of the training program materials. Because there was a commitment to a CRI approach whether we acquired a CBT system or not it was apparent that the development costs would be similar so they were not assigned to the cost of the CBT system.

As is often the case, our plans didn't match what actually happened.

In the first place we had more students than we anticipated. We had planned for 367 students for the year and by the end of December there had been 461 students in the program. Figure 5 shows those figures.

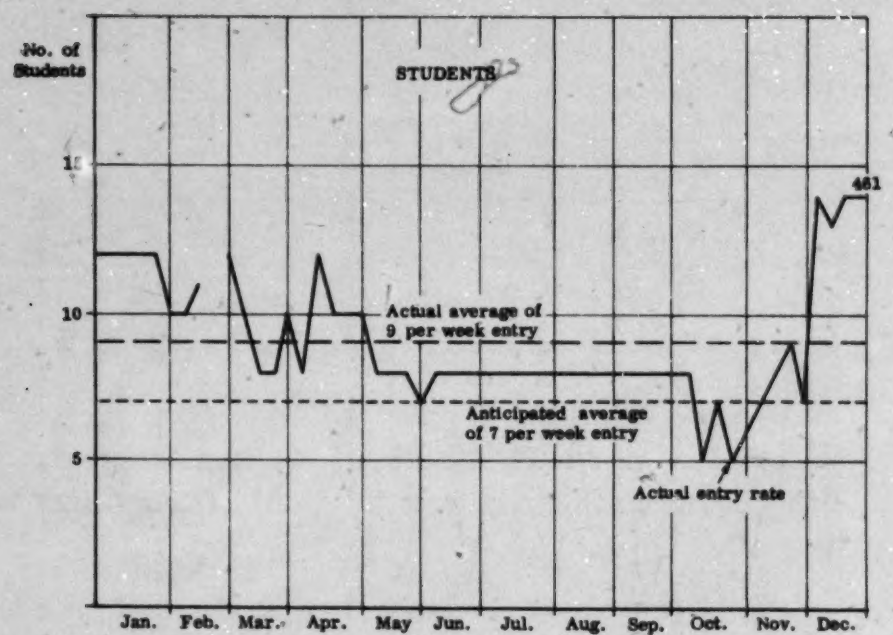

FIGURE 5

A worthwhile benefit of the CBT system is that we were able to handle a variable student entry rate without adding any instructors and were able to vary PLATO resources to match our needs. These factors contributed favorably to our costs.

Our proposal stated that a manually run CRI program would result in an average of 15 days in training. We estimated the average to be 11 days with a CBT system. The actual result was an average of 9.5

days. (The actual average does not take into account any fractional days, i.e., even though a student only had to master one criterion test the last day, it was counted a full day.) See Figure 6.

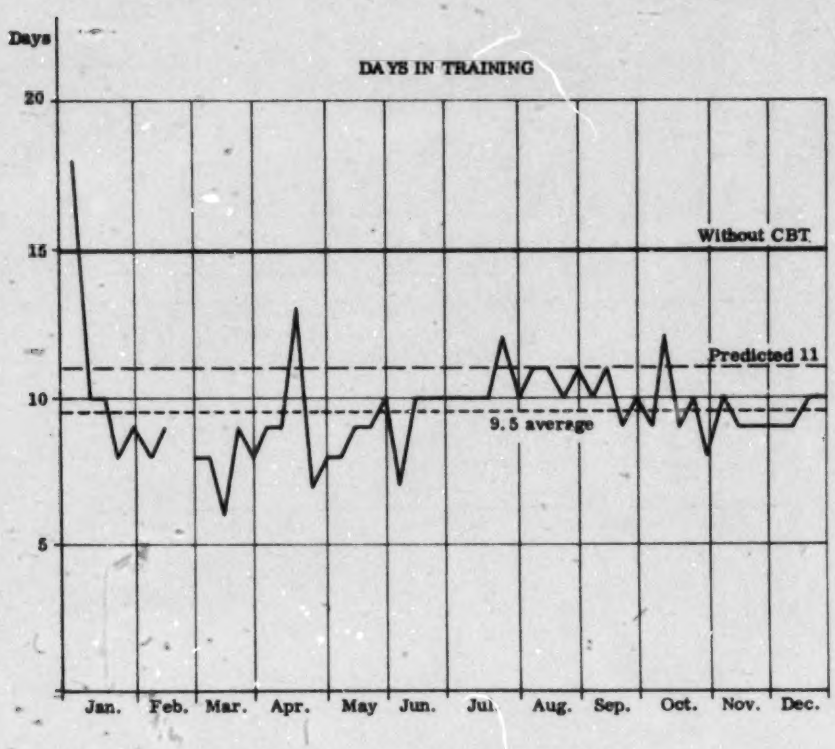

FIGURE 6

Figure 7 shows the costs for student time at an average of 15 days per student and 9.6 days per student. Compared to our estimates of 11 days there was an additional savings of $22,968.

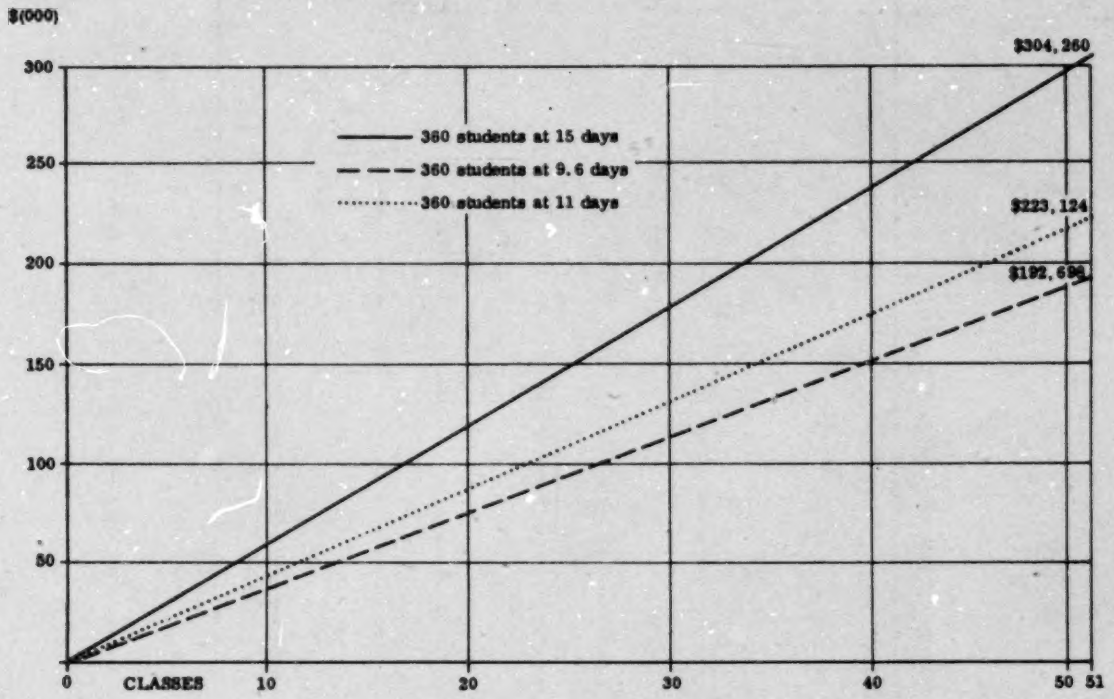

FIGURE 7

Another benefit of the reduced time as opposed to a lock-step program is the fact that students are available for their jobs earlier.

Figure 8 compares the total numbers of students that could finish training in 51 weeks according to the indicated average training times. The fifth column is the number of students who have completed all training (approximately 5 weeks in addition to the New Hire program)

and are on the line as productive flight crew members. NOTE: The actual number is larger than the average-based number because many students finish the New Hire program in less than average time, some in as few as 4 days.

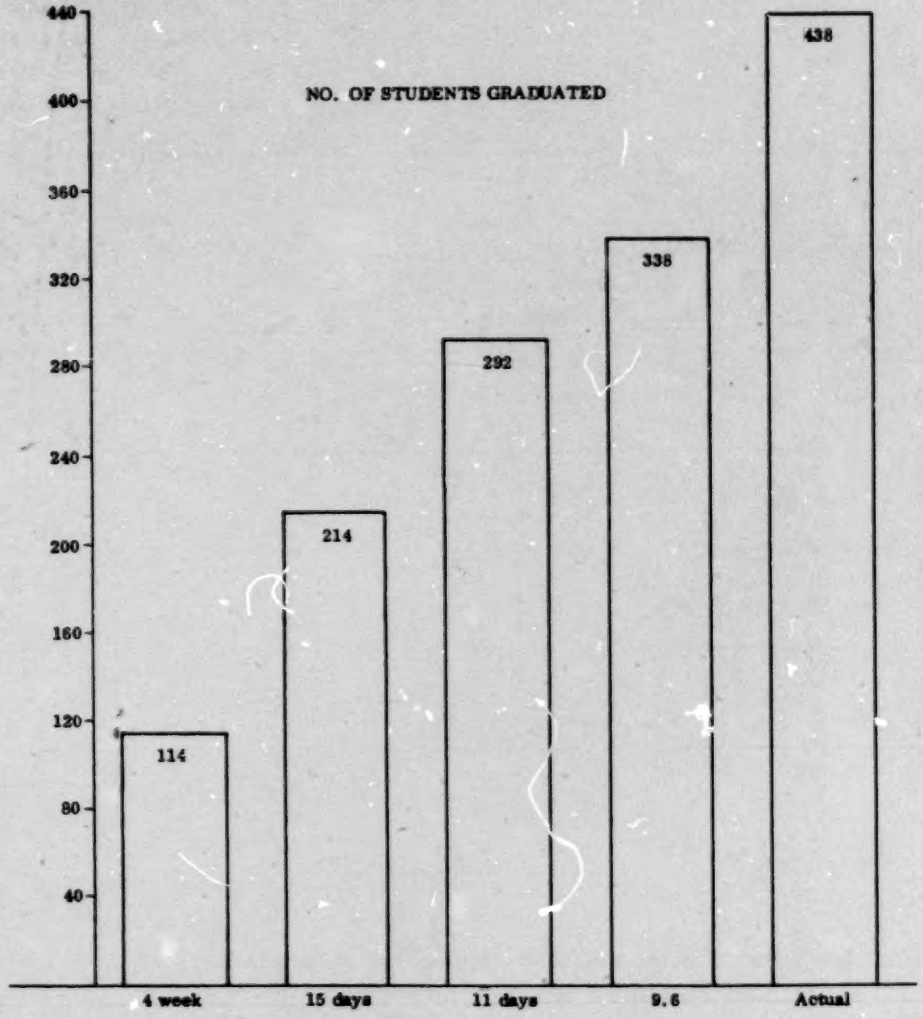

FIGURE 8

Additional savings have been realized in instructor costs. The estimated need for 7 Flight Operations Instructors if the CRI program had been administered without a CBT system is used as the basis for comparison. With a CBT system we estimated the need for 5 Flight Operations

Instructors. Flight Operations Instructors are highly qualified people. Many are pilots with extensive experience and all have experience as licensed Flight Engineers. Most of the Flight Operations Instructors in the Training Center are qualified as a Flight Engineer on the particular airplane that they teach and do in fact maintain their qualification to operate as a flight crew member.

When the CRI was begun for the New Hire program, 3 Flight Operations Instructors were assigned to man the Learning Center to assist the students by answering their questions, helping them with PLATO and assuring the security of our tests.

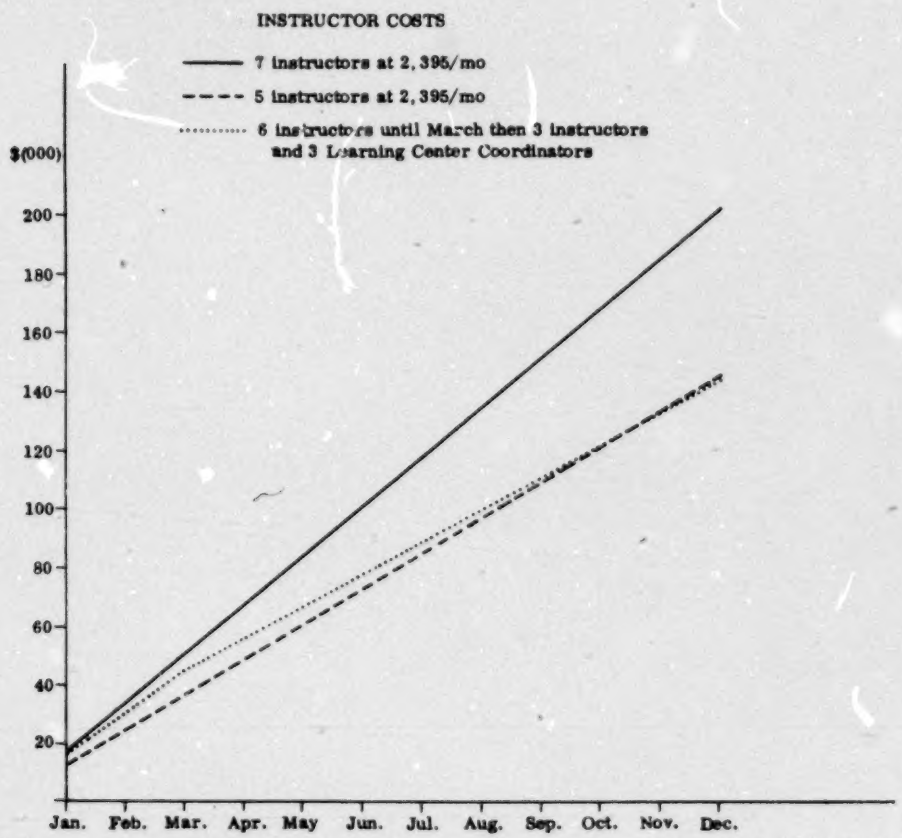

FIGURE 9

Within a few weeks the instructors asked to be relieved of their duties in the Learning Center on the basis that what they were doing could be done by clerical people. As a result the 3 Flight Operations Instructors were used in other airplane programs and 3 Learning Center Coordinators were hired to replace them at less than half the cost. Figure 9 shows the effect of that savings.

Figure 10 shows the relationship for the total cost savings of student salaries and instructor costs to the cost of having the PLATO CBT system. In 12 months a savings of $72,221. has been realized.

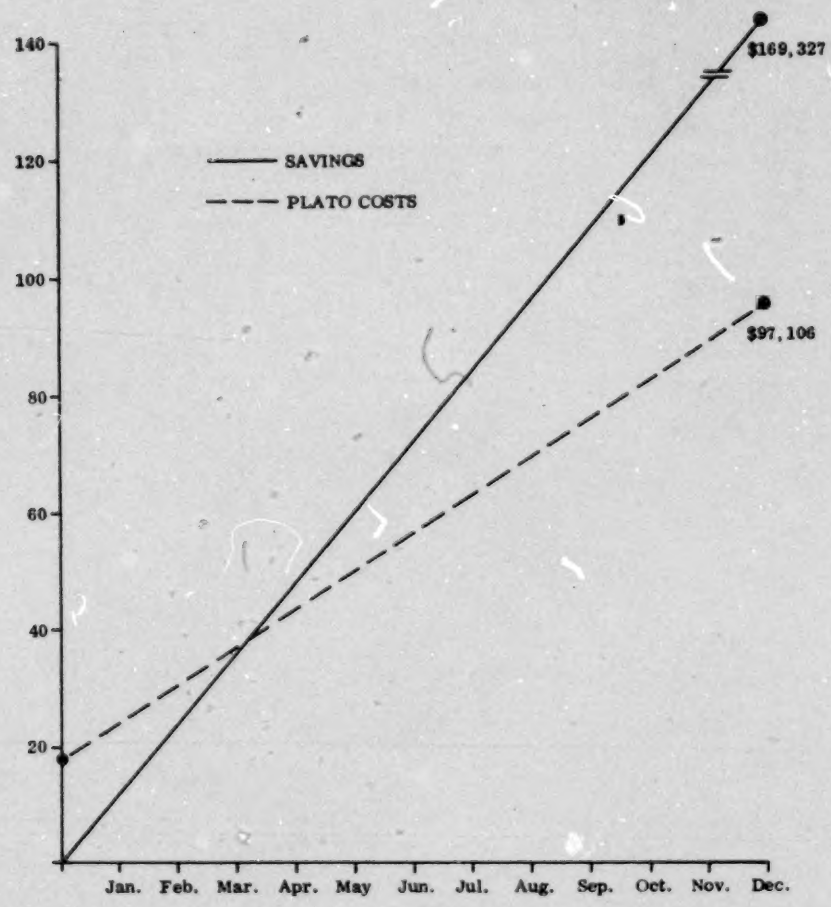

FIGURE 10

Clearly the application of Criterion Referenced, Individualized Instruction as administered with the help of a CBT system having good CMI capabilities is paying off for United Airlines Flight Training.

The figures used have been conservative to the extent that the Pilot Skills Training and Assessment portion of the newly hired pilots training has not been figured into this outcome. That program uses an average of 5 hours in a flight simulator over a period of 3 days for each student. This program was initiated after initial planning for the course was completed and was incorporated in the students training in conjunction with their working on the CRI part of the course.

It should be noted that this program does not use any CAI for learning resources. There are two program development efforts currently in progress that will use a combination of learning resources including the simulation capabilities of the PLATO system. There are two additional programs in preparation that will use the CBT system in a manner similar to the New Hire program. Each new application is evaluated and adopted if it seems to be cost effective. Our experience with PLATO has given us a sound basis on which to make these decisions. We are planning to conduct our entire Boeing 767 transition training program using Criterion Referenced Instruction with a CBT system to manage all aspects of the course from knowledge skills through exercises and practice in the airplane simulator.